

this fact, together with the timely warnings, prevented any damage of consequence.

The Black and lower White rivers of Arkansas were above flood stage thruout the month, and there was also a decided flood in the upper White River about the middle of the month.

When the great Red River flood began on the 25th, the more moderate one of the middle of the month was still in progress east of the Arkansas line. The great flood was in full progress at the close of the month, and a report thereon will appear in the MONTHLY WEATHER REVIEW for June, 1908.

Rains in the Kansas, Missouri, and Mississippi valleys were frequent and heavy, causing general rises in the rivers, but at the end of the month floods had not set in, except in the Mississippi River between Keokuk, Iowa, and Hannibal, Mo., and in some of the upper tributaries of the Mississippi, especially the St. Croix, Minnesota, and Illinois rivers. Warnings were issued at the proper times for these floods. The rise in the vicinity of Keokuk was mainly from the Des Moines River, and while considerable damage was done to crops, principally thru the breaking of a small private levee between the Des Moines River and the town of Alexandria, Mo., a four-inch deposit of rich soil offset the losses.

The lower Mississippi River was uniformly high, altho not dangerously so, except from New Orleans, La., southward.

The rise that began about the 7th in the upper Ohio River and tributaries did not result in flood stages, except from Evansville, Ind., to Cairo, Ill., where the flood lines were slightly exceeded. Not much direct damage was done, but farming operations, especially corn planting, were greatly de-

layed. Heavy rains from the 4th to the 6th, inclusive, also caused moderate floods in the Scioto and Great Miami rivers of Ohio, and the warnings issued for the same were fully verified. The damage done was not extensive.

The Grand River of Michigan was in moderate flood from the 9th to the 24th, inclusive. Advices were given when necessary, and there were no unpleasant features, except some slight inconvenience in the lowlands.

The rivers of the Gulf of Mexico system east of the Mississippi River were in flood during the early days of the month as a result of heavy general rains during the last few days of April. In fact the lower Flint and lower Chattahoochee rivers were already in flood at the beginning of May. Flood warnings were issued for the Flint, Chattahoochee, and Apalachicola rivers on April 27, and they were reported to have been of much value to the lumber, cattle, and mill interests. Floods of a similar character occurred in the Black Warrior and lower Tombigbee rivers, and in the Pascagoula and Pearl rivers of Mississippi, for which warnings were issued when indicated.

The Columbia River continued to rise thruout the month.

The highest and lowest water, mean stage, and monthly range at 215 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—H. C. Frankenfield, *Professor of Meteorology.*

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

WEATHER INFLUENCES PRECEDING THE EVACUATION OF BOSTON, MASS.¹

By WALTER N. LACY. Dated Harvard University, May 11, 1908.

In a recent study of some climatic influences on American history the writer found reference to the weather conditions which played an important part in the closing history of the siege of Boston. A careful investigation of all available data on the subject led to the preparation of this paper and of the accompanying maps of the probable weather conditions in the vicinity of Boston for March 4, 5, and 6, 1776. The maps were drawn from the available data of the local weather conditions at the time and upon present knowledge of the nature, tracks, and velocity of storms in the eastern part of the United States. (See fig. 1.)

Following the battle of Bunker Hill and the arrival of General Washington as Commander-in-Chief in the summer of 1775, the continental forces kept a blockade around the city of Boston all thru the following winter. As spring advanced Washington resolved upon some effective move, and with the consent of his officers prepared to fortify Dorchester Heights, a position which so commanded Boston and the harbor as to make untenable the British position as long as the Americans occupied those heights. During the first few days of March, 1776, preparations were hurried for effecting Washington's plan, and on the nights of Saturday and Sunday, March 2 and 3, cannonading was kept up by the continental forces from Lechmeres Point, Cobble Hill, and Lambs Dam, Roxbury, near the present lead works on Albany street. (See the accompanying sketch map, fig. 2.)

¹ Part of a thesis prepared in the course in advanced climatology given by Prof. R. DeC. Ward, in Harvard University, during the year 1907-8. The references consulted in the preparation of this paper include histories of the United States, the Revolutionary War, and Boston; a memorial address on the Centennial of the Evacuation, by George E. Ellis, D.D.; published letters or journals of Lieut. William Carter of the British Army, George Washington, and Daniel McCurtin; manuscripts by Timothy Newell, Doctor Holyoke, and Professor Winthrop; and Prof. Edward B. Garriott's "Cold Waves and Frost in the United States." Grateful mention must also be made of the suggestions received from Mr. J. W. Smith, District Forecaster at Boston, Mass.

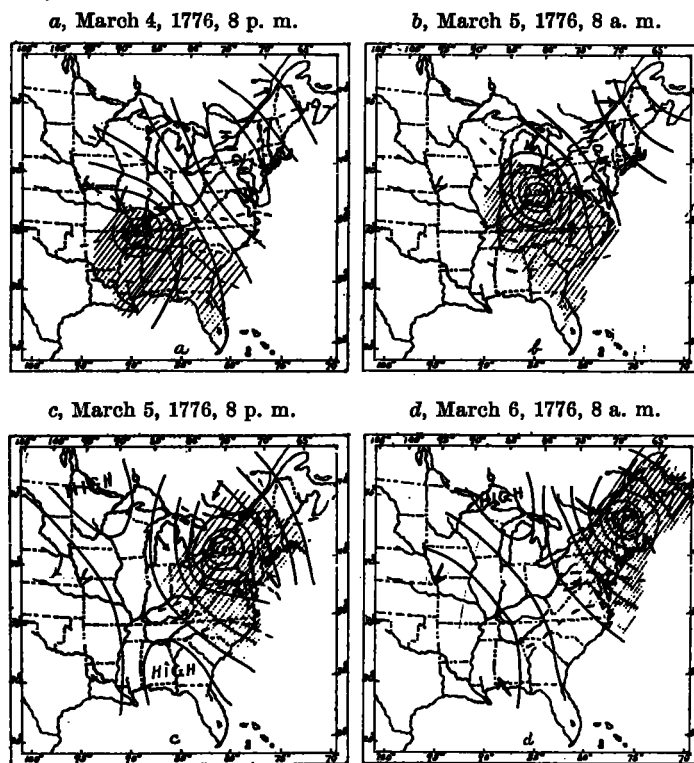


FIG. 1.—Maps showing probable weather conditions in eastern United States during operations preceding evacuation of Boston, Mass.

Monday evening, March 4, everything was in readiness and the night was unusually favorable for the execution of Washington's plan. Between 7 and 8 o'clock some two thousand men, including a covering party, moved toward Dorchester Heights, under command of General Thomas. The ground, to a depth of some 18 inches, was frozen so hard that it could not be thrown up as breastworks, and fascines and

chandeliers (wooden frames) were carried by the American troops with which to erect their fortifications. Altho the ground was frozen, yet by reason of a southwest wind the night was "remarkably mild," and the light of the full moon aided the men in their work. A light haze, or perhaps a radiation fog with the moist southwest wind, combined with the smoke from the cannonading which the Americans had commenced earlier in the evening, settled down over the town and the lowlands and concealed the progress of the work on the heights.

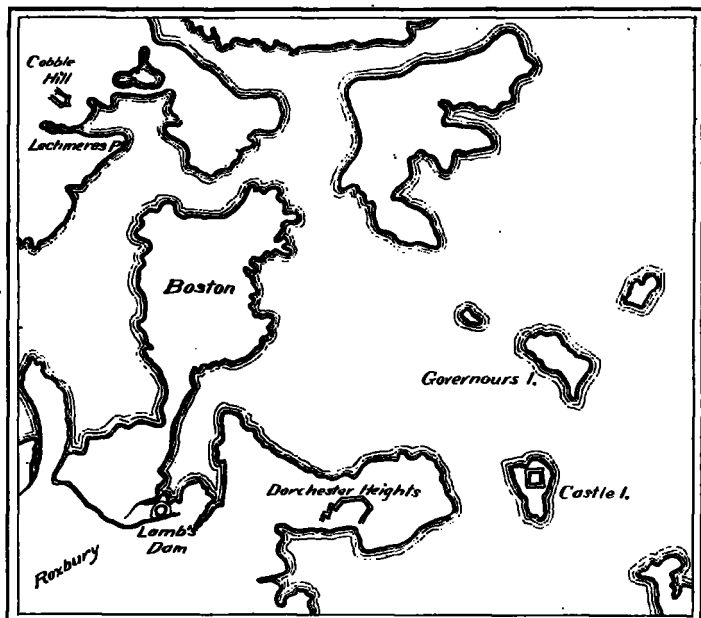


FIG. 2.—Sketch map of Boston with its environs in 1775 and 1776. (From Frothingham's History of the Siege of Boston.)

The cannonading of the night, the southwest wind carrying any sound of the American operations out toward the bay, and the smoke and fog kept the British from any suspicion of what Washington's men were doing, so that when morning broke Howe's men were much surprised to find what the Americans had accomplished during the night. Looking thru the early morning fog, the fortifications "seemed of indefinite magnitude," and both General Howe and Admiral Shulldham realized that their positions were insecure as long as the Americans remained on Dorchester Heights. Consequently General Howe decided to prepare to attack, and about noon between two and three thousand men, under command of General Jones, began to embark in transports. The plan was for them to drop down in the late afternoon or early evening to Castle Island, whence they could cross to the cove southeast of the American position and attack the Americans from the rear early Wednesday morning.

Tuesday morning had dawned clear and mild, with a bright sun and a warm southerly wind. During the afternoon, however, the storm which had been indicated by preceding fog and winds, and which had probably been advancing up the Ohio Valley, must have reached New York State. A marked low-pressure area there would have produced strong southeast winds in the vicinity of Boston. In the afternoon the wind blew furiously, so billowing the harbor that three of the transports were blown upon Governors Island before reaching the Castle. By night a "rank storm," as one of the British officers called it, had set in with a fury "such as few remember to have heard," and the rain fell in torrents, so drenching the Americans who had all day continued to strengthen their position, that one of them wrote in his journal "I never before felt such cold and distress as I did this night, and I believe it was the case in general with our men."

As morning drew near there was no abatement of the storm, and Wednesday, March 6, commenced amid torrents of rain and a boisterous wind from the southeast. The center of the storm had probably past into northern Vermont or New Hampshire, and with the furious southeast gale that was blowing, such a surf beat upon the Dorchester shore where the troops must have landed, that "an attempt to land must have proved fatal."

Altho the rain and the wind continued the greater part of Wednesday with little less fury the time was not being lost by the men under General Thomas. When the storm and the surf had sufficiently subsided for the British to attack, they realized that the American position was too strong for them, and by night (Wednesday, March 6) the evacuation of Boston had been decided upon. Eleven days later the city was abandoned, and the entire force under General Howe dropt down in their transports toward Nantasket, sailing thence for Halifax ten days later.

Of the British plan and the results of the storm General Washington wrote Major-General Lee on March 14, as follows: "A very heavy storm of wind and rain frustrated their design; in my opinion the most fortunate circumstance for them and unfortunate for us that could have happened, as we had every thing so well prepared for their reception that I am confident we should have given a very good account of them." Whether Washington was right, and whether the British must have evacuated the city had they attacked, will never be known; but it seems certain that the closing chapter of the siege of Boston would have been different had the weather not frustrated General Howe's plans.

THE WORK OF PROF. CARL STÖRMER ON BIRKELAND'S THEORY OF THE AURORA BOREALIS.

By JOHN A. ANDERSON, Ph. D. Dated Johns Hopkins University, Baltimore, Md., May 29, 1908.

The general appearance of the streamers, bands, etc., of the aurora borealis is so similar to some of the phenomena accompanying the passage of cathode rays thru rarified gases that most of the modern theories which aim to account for it assume that the aurora is produced by cathode rays passing thru the upper atmosphere. The altitude at which the aurora appears (about 40 miles), where the atmospheric pressure is about what is commonly found in our vacuum tubes, tends to support this view as to the cause of the luminous phenomena observed. Another fact also pointing to the same conclusion is that the streamers increase in intensity downward, which is what we should expect since cathode rays are more strongly absorbed the greater the pressure of the gas thru which they pass, and hence with increase of pressure the luminosity of the air caused by them should increase up to very near the point where they are completely absorbed.

The theories of the aurora accordingly differ chiefly in the way in which they account for the origin of the cathode rays. The fact that great auroras very frequently are seen at a time when some sun spot is showing unusual activity has led to the general belief that the first cause of the aurora is to be sought in the sun.

There are three theories which seem to be able to account in a more or less satisfactory manner for the chief characteristics of the aurora. These are (1) the theory of Arrhenius (Ofversigt, 1900); (2) the theory of Nordmann; (3) the theory of Birkeland (Archives, 1896).

(1) Arrhenius's theory assumes that the sun sends out negatively charged particles (larger than atoms) which, repelled by light pressure, reach our atmosphere, where they are discharged by ultra-violet light from the sun, thus giving rise to cathode rays, which move in spirals around the magnetic

*Jared Sparks: The Writings of George Washington. Vol. III. (Hilliard, Gray & Co. Boston. 1834.)